Case **BARRY-014A**

AN APPARATUS AND METHOD FOR FORMING A DUAL RADIUS ARCH MOUNTING STRUCTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not Applicable

STATEMENT RE: FEDERALLY SPONSORED RESEARCH/DEVELOPMENT

[0002] Not Applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0003] The present invention relates to the art of building construction, and in particular, apparatuses and methods for forming arched frames that may be utilized in new construction or in retrofitting or remodeling existing structures. The present invention is even more particularly applicable to apparatuses and methods for forming dual radius arched doorway structures, niches and various interior openings.

2. Background of the Invention

[0004] A dual radius arch frame is defined by a generally horizontal oriented base frame portion and a dual radius arch frame portion. Referring to Figure 2, in general, the dual arch radius frame portion has three sections including a center arch span 10, a left downwardly curved section 9, and a right downwardly curved section 11. The center arch span 10 is defined by a first radius length R_3 having a laterally offset center point 15 which is geometrically positioned underneath the concave side of the center arch span 10. The left and right downwardly curved sections 9, 11 are formed from radiuses having a shorter second radius length R_4. The dual

radius arch frame is then formed by tangentially connecting the left and right sections 9, 11 to the center arch span 10 at tangents points τ L and τ R .

[0005] Traditionally, the placement, mounting and peripheral enclosure of modern, interiorly mounted dual radius arched windows has heretofore required considerable skill and labor. The conventional prior art methods of installing dual radius arched frames required cutting and nailing of short sections of two-by-four or other wooden material between adjacent wall studs and under a "header" to roughly approximate a dual radius arched pattern so as to generally correspond with the desired dual radius arched shape. The interior drywall or other wall covering material is then cut according to the dual radius arched shape of the doorway and nailed over the top of the roughly arranged two-by-four support sections.

[0006] Provided that the drywall has been correctly cut and properly placed against the underlying two-by-four support, the builder must then "fill in" the area between the dual radius arched edge of the drywall and the frame to create a smooth dual radius arched jamb such that the jamb will be perpendicular at any given point to the interior wall surface. The creation of such jamb often requires the insertion of plywood or other filler materials in an effort to occupy any void existing between the interior drywall and the hidden framing. After such void has been filled, plaster or other appropriate filler materials must then be applied to form the desired dual radius arched frame surface.

[0007] The above described prior art methods of mounting and finishing dual radius arched frames are known to be time consuming and to result in non-uniform and often times uneven interior wall surfaces. Thus, there exists a need in the art for a simple, inexpensive and uniformly shaped dual radius arched mounting structure which may be inserted between the conventional wall framing and the dual radius arched frame so as to provide a uniform framing surface.

[0008] One known method to overcome the aforementioned dilemma is to manufacture a preformed arch as taught in U.S. Patent No. 4,955,168, entitled "Mounting Structure For Arcuate Window Frames" to Barry, the subject matter of which is incorporated herein by reference. Barry teaches a process to manufacture a preformed arcuate window frame support structure which may be easily installed into the framing of a building, thus, eliminating the need to manually form the arched window frame in the traditional manner. To assist in the manufacture of the preformed arcuate window frame support structures, Barry teaches applying individual

laminates around an arcuate jig structure and bonding them with glue which results in a rigid laminated structure having the desired semi-circular arcuate shape. However, Barry does not address how to manufacture preformed dual radius arch window frame supports. Instead, Barry only teaches how to manufacture semi-circular arches.

[0009] And even if the method taught by Barry is applied to the manufacture of interior dual radius arch frame mounting structures, there are other existing challenges indigenous to the manufacture of dual radius arch preformed window frame supports which are not experienced in the manufacture of a more basic semi-circular arched preformed frame support. Mainly, the problem is that dual radius arch designs may conform to numerous permutations and combinations of arch size selections, whereas, semi-circular arches only differ by radius. For instance, the radius of the left and right downwardly regions 9, 11 may be perhaps 6", 8", 10", 12", 14" and the center arch span 10 may have a radius of 42", 44", 48", 50", 52" or 54". It is easy to see then, that numerous permutations and combinations of dual radius arch designs may be generated. A disadvantage to this process is that an individual jig must be built for each specific dual radius arch shape. Building various jigs to meet various standard and custom ordered dual radius shapes becomes not only time consuming, but is also very expensive.

[0010] In view of the aforestated problems of the prior art, it would be advantageous to provide a forming apparatus or jig which may be adjusted to produce a variety of permutations and combinations of dual radius arch frame mounting structure shapes without requiring a individualized specific jig for each specific desired shape of dual radius arch frame mounting structure.

BRIEF SUMMARY OF THE INVENTION

[0011] The present invention overcomes the aforementioned disadvantages by providing an apparatus and method for forming a dual radius arch frame. An exemplary embodiment of the apparatus may include a longitudinal member having a centerline and centerpoint; a laterally adjustable support having one end attached to the centerpoint of the longitudinal member in a perpendicular orientation and a vertical support attached to a distal end of the laterally adjustable support; a left outer form having a generally semi-circular shaped arch centered and oriented about a left pivot axis located on the centerline a predetermined distance from the centerpoint; a right outer form having a generally semi-circular shaped arch centered and oriented about a right

pivot axis located on the centerline a predetermined distance from the centerpoint; an arched shaped center cord adapted to be connected to a receiving edge of the left outer form and of the right outer form in a tangentially continuous manner; at least one adjustable left strut assembly interconnecting the left outer form to said vertical support; and at least one adjustable right strut assembly interconnecting the right outer form to the vertical support.

[0012] According to an aspect of the present invention, the present invention may further include a set of preformed arched shaped center cords each having a different shape, wherein each center cord may be separately installed into the apparatus to vary the size of the dual radius arch frame to be formed. Another aspect of the present invention allows at least one of a radius measurement R_3 and arc length measurement l of each cord to be varied. A further aspect of the present invention includes a matching set of preformed left and right outer forms, each matching set having a different radius R_4, wherein each matching set may be installed into the apparatus to vary the size of the dual radius arch frame to be formed.

[0013] According to yet another aspect of the present invention, the dual radius arch frame may be defined by a width W, arch height H, span length L and thickness T. Additionally, the dual radius arch frame may be defined by a left and right outer form radius R_4 and wherein the center cord has a radius R_3 and arc length measurement l. Moreover, the left and right pivot axis are equally spaced a distance $1/2L - R_4$ from the centerpoint of the longitudinal member. Another aspect of the present invention further includes a center strut assembly interconnecting the left outer form and the right outer form.

[0014] Another aspect of the present invention includes a plurality of laminate sheets conformally wrapped around the left outer form, the center cord, and the right outer form. Other aspects of the present invention include a plurality of winch assemblies attached to the vertical support, the winch assemblies connected to a plurality of respective individual straps wrapped around the plurality of laminate sheets, the plurality of winch assemblies adjusted to tightly hold the plurality of respective individual straps around the plurality of laminate sheets.

[0015] Another exemplary embodiment of the present invention is provided which is an apparatus for forming and manufacturing a dual radius arch frame. The exemplary apparatus may be composed of a horizontally oriented longitudinal member having an upper surface, a left side region, a center, and right side region, and plurality of aligned mounting bores laterally spaced apart in even increments traversing said longitudinal member; a laterally adjustable

support assembly having one end attached to the center of the longitudinal member in a perpendicular orientation and a distal end, and further including a vertical support attached to the distal end, the vertical support having at least one left strut swivel attach point and at least one right strut swivel attach point; a left outer form having a generally semi-circular shaped arch centered and oriented about a left pivot axis positioned within one of the plurality of mounting bores located on the left side region of the longitudinal member, the left outer form having a left cord receiving edge and at least one left outer form swivel attach point; a right outer form having a generally semi-circular shaped arch centered and oriented about a right pivot axis positioned within one of said plurality of mounting bores located on the right side region of the longitudinal member, the right outer form having a right cord receiving edge and at least one right outer form swivel attach point; an arched shaped center cord section having a left attaching edge and a right attaching edge, the left attaching edge adapted to be connected to the left cord receiving edge of said left outer form and the right attaching edge adapted to be connected to the right cord receiving edge of the right outer form; at least one adjustable left strut assembly having a left outer form attaching end and a left vertical support attaching end, the left outer form attaching end swivel attached to one of the at least one left swivel attach points, and the left vertical support attaching end swivel attached to at least one left strut swivel attach point; and at least one adjustable right strut assembly having a right outer form attaching end and a right vertical support attaching end, the right outer form attaching end swivel attached to one of the at least one right swivel attach points, and the right vertical support attaching end swivel attached to at least one right strut swivel attach point.

[0016] Another aspect of the instant exemplary embodiment includes an arched shaped center cord comprised of a laminate material. A further aspect of the instant invention further includes a set of preformed arched shaped center cords, each center cord having a different shape, wherein each center cord of said set may be separately installed into the apparatus to vary the size of the dual radius arch frame to be formed and manufactured. Additionally, at least one of a radius measurement and radial arc length measurement of each cord may be varied.

[0017] According to an aspect of the present invention, a matching set of preformed left and right outer forms, each matching set of preformed left and right outer forms having a different radius, wherein each matching set of preformed left and right outer forms may be installed into the apparatus to vary the size of the dual radius arch frame to be manufactured. Moreover, the

dual radius arch frame is defined by a width W, arch height H, span length L and thickness, the dual radius arch frame is further defined by a left and right outer form radius defined by R_4 and wherein the center cord has a radius defined by R_3 and arc length measurement *l*, and the left and right pivot axis are equally spaced a distance $1/2L - R_4$ from the centerpoint of the longitudinal member.

[0018] Another aspect of the instant embodiment of the present invention includes at least one adjustable left and right strut assembly each comprising a strut member adapted to internally receive a threaded strut member and a collar having receiving threads for adjusting the length of the strut assembly. Another aspect of the present invention includes a center strut assembly interconnecting the left outer form and the right outer form. Additionally, a plurality of laminate sheets may be conformally wrapped around the left outer form, said center cord, and the right outer form. Furthermore, the instant exemplary embodiment may further include a plurality of winch assemblies attached to the vertical support, the winch assemblies connected to a plurality of respective individual straps wrapped around the plurality of laminate sheets, the plurality of winches adjusted to tightly hold the plurality of respective individual straps around the plurality of laminate sheets.

[0019] According to another aspect of the present invention a method for forming a dual radius arch window frame mounting structure utilizing a forming apparatus is provided. The method may include the steps of establishing a width W, arch height H, span length L and thickness T of a dual radius arch frame to be formed; defining the dual radius arch frame by selecting a left and right outer form radius R_4 and positioning a left and right outer form having a radius R_4 at a left and right pivot axis equally spaced a distance $1/2L - R_4$ from a centerpoint of a longitudinal member; further defining the dual radius arch frame by a radius defined by R_3 and arc length measurement *l* and positioning a center arch span having a radius R_3 and arc length measurement *l* in the forming apparatus such that the center arch span tangentially interconnects the left and right forms forming a complete dual radius arch form; applying a plurality of laminates with adhesive there between to the complete dual radius arch form to form a dual radius arch frame; surrounding the complete dual arch radius form and precut dual radius arch frame with a plurality of tensioned straps; allowing the adhesive to set-up; removing the plurality of tensioned straps from the forming apparatus; and cutting the dual radius arch frame along an arch baseline to provide a finished dual radius arch frame mounting structure.

[0020] The exemplary method of the present invention may also include utilizing at least one adjustable left strut assembly and right strut assembly to interconnect the left and right outer forms, respectively, to a vertical member laterally offset from the centerpoint of the longitudinal member and geometrically positioned underneath the center arch span, to provide additionally bracing to prevent the deformation or buckling of the complete dual arch radius form when the straps are applied to the dual radius arch frame. Moreover, the exemplary method may include utilizing a center strut assembly to interconnect left outer form and right outer form to prevent the deformation or buckling of the complete dual arch radius form when the straps are applied to the dual radius arch frame.

[0021] Other exemplary embodiments and advantages of the present invention may be ascertained by reviewing the present disclosure and the accompanying drawings

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The present invention is further described in the detailed description that follows, by reference to the noted drawings by way of non-limiting examples of preferred embodiments of the present invention, in which like reference numerals represent similar parts throughout several views of the drawings, and in which:

[0023] Figure 1 depicts an exemplary embodiment of dual radius arch frame mounting structure;

[0024] Figure 2 is a notational schematic which depicts geometric relationships that define a dual radius arch;

[0025] Figure 3 shows an aspect of a lamination technique utilized to manufacture a dual radius arch frame mounting structure, according to an aspect of the present invention;

[0026] Figure 4 is a cross sectional view taken through line A-A of Figure 1;

[0027] Figure 5 illustrates a dual radius arch installed in an exemplary doorway structure utilizing a dual radius arched frame structure, according to an aspect of the present invention;

[0028] Figure 6A is a top view of an exemplary forming apparatus utilized to manufacture a dual radius arch frame mounting structure, according to an aspect of the present invention;

[0029] Figure 6B is the same view as Figure 6A, but also shows the mounting structure formed and strapped to the forming apparatus, according to an aspect of the present invention;

[0030] Figure 7A is an upper rear side perspective view of the forming jig, according to an aspect of the present invention;

[0031] Figure 7B is the same view as Figure 7A, but also shows a dual radius arch frame structure formed and strapped to the forming apparatus, according to an aspect of the present invention;

[0032] Figure 8A is an upper front side perspective view of the forming apparatus, according to an aspect of the present invention; and

[0033] Figure 8B is the same view as Figure 8A, but also shows a dual radius arch window frame structure formed and strapped to the forming apparatus, according to an aspect of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0034] The particulars shown herein are by way of example and for purposes of illustrative discussion of the embodiments of the present invention only and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the present invention. In this regard, no attempt is made to show structural details of the present invention in more detail than is necessary for the fundamental understanding of the present invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the present invention may be embodied in practice.

[0035] The present invention provides an apparatus or jig 5 and method for forming a dual radius arch mounting structure 2. A general description of the dual arch radius frame mounting structure 2 is initially provided. A detailed description of the forming apparatus or jig 5 is then provided. Finally, a method on how to utilize the forming apparatus 5 to manufacture the dual radius arch mounting structure 2 is described.

General Description of a Dual Radius Arch Mounting Structure

[0036] Figure 1 depicts an embodiment of a dual radius arch frame mounting structure 2. The mounting structure 2 may have a specified span length L, center arch height H, width W, and thickness T. In regard to construction, the span length L determines the span length of the frame and the center arch height H determines the height of the arched frame. The dual radius

arch mounting structure 2 is adapted to provide a conformally fitting arched frame which provides upper framing structure for doorway structures, niches and various interior openings. To be able to better appreciate the present invention, it is first important to understand the geometric relationships which are present in a dual arch radius.

[0037] Figure 2 is a notational schematic which depicts the geometric relationships that define a dual radius arch. In general, a dual arch radius has three sections including a center arch span 10, left downwardly curved section 9, and right downwardly curved section 11. The center arch span 10 is defined by radius R_3 which has a laterally offset center point 15 and of which is geometrically positioned underneath the concave side of center arch span 10. The left and right downwardly curved sections 9, 11 are formed from radiuses having a shorter radius length R_4 about left centerpoint 13 and right centerpoint 14. An arch baseline 12, which represents the bottom of the dual radius arch, intersects the center points 13, 14 at which the left and right downwardly curved regions 9, 11 are formed. Each radius furthermore defines tangent points τ_L and τ_R which are the points at which the center arch span 10 smoothly converges with the left and right downwardly curved sections 9 and 11. It can be appreciated that a dual radius arch may have varying shapes. In particular, radius R_3 and R_4 may each be varied. Thus, numerous permutations and combinations of R_3 and R_4 may be selected resulting in various dual arch radius shapes.

[0038] Figure 3 shows an aspect of a lamination technique utilized to form a dual radius arch frame mounting structure 2. In particular, the mounting structure 2 is made from a plurality of individual laminate sheets 16 that are stacked upon each other, and furthermore, glued together with a laminate adhesive 17, such as wood glue or any other adhesive known in the art. The laminate sheets may have any thickness normally utilized in laminate manufacturing. For example, the preferred thickness of the laminate sheet may be 1/8 inch for the exemplary embodiment of the present invention. The laminate sheet may be made from materials typically used to manufacture laminate products, for example, wood, fiber board or particle board to name just a few.

[0039] Figure 4 is a cross sectional view of the mounting structure 2 taken through cross-section line A-A of Figure 1. This cross section shows each individual laminate sheet 16 stacked and glued to each other forming a rigid board like structure.

[0040] Figure 5 illustrates an exemplary use of a dual radius arch frame assembly mounting structure 2. Conventional framing 4 techniques are utilized to frame in the conventional doorway 6, niche or any other arched structural feature. Also, conventional framing 4 is installed overhead to mount the dual radius arch frame mounting structure 2.

Detailed Description of the Forming Apparatus

[0041] Figures 6A, 7A, and 8A illustrate an exemplary embodiment of a forming apparatus or jig 5 that may be utilized to fabricate a dual radius arch frame mounting structure 2.

[0042] Figure 6A is a top view of the forming apparatus 5. The main components of forming apparatus 5 may include a longitudinal member or main jig 36, lateral jig 56, left outer form 18, right outer form 19, center cord section 21, left adjustable strut assembly 41, right adjustable assembly 42, vertical support 54, lateral support 58, center strut assembly 70 (see Figure 6B), and a plurality of winches 60-63 (see Figure 6B) and individual straps 64-67.

[0043] The backbone of the forming apparatus 5 is the main jig 36 which is best illustrated in Figure 6A. The main jig 36 provides a plurality of generally aligned positional mounting bores 25 which are adapted to receive left pivot bolt 30, right pivot bolt 33, and lateral jig bolt 57. The positional mounting bores 25 are positioned on jig 36 at intervals, for example ½ inches apart, giving the jig 36 the ability to accommodate numerous arch span lengths L. The mounting bores 25 may be staggered in an upward and downward pattern to provide sufficient material for the structural integrity of each bore 25. The main jig 36 is preferably made from steel. One embodiment of the main jig 36 utilizes a pair of square tubes with preformed holes spaced every inch. The jig 36 may be fabricated by positioning the pair of square tubes contiguously next to each other, offsetting the preformed holes from one tube to the other by a half interval, and by welding the pair of square tubes together. Thus, a longitudinal member, or main jig 36, is formed having mounting bores positioned in an alternating upward and downward position which allows for ½ inch positional increments.

[0044] The left outer form 18 and right outer form 19 are best illustrated in Figures 6A, 7A and 8A. The left outer form 18 comprises a partial semi-circular left forming arch 22 mounted upright in a perpendicular manner to a left outer form plate 24. The left forming arch 22 is centered about a left pivot axis 30 having a radius R_4. The shape of the left outer form plate 24 of the exemplary embodiment conforms to a trapezoidal shape, however, the shape may vary as

long as it performs the same function. The left outer form plate 24 has numerous functions including, providing structure for the left pivot axis 30, providing mounting structure for the left forming arch 22, and providing structure for securing or attaching devices, such as C-lamps or vice grips, (not shown or within the scope of the present invention) to secure and/or attach the left outer form plate 24 in a rigid stationary position to fixtures (not shown). Supporting structure 84 may also be provided underneath left outer form plate 24. For example square steel tubing may be utilized as the support structure 84. Left outer form plate 24 has a left pivot hole 80 which is positioned at the left pivot axis 30. A left receiving edge 86 for receiving the center arched cord section 21 is provided along one of the vertical edges of the left forming arch 22. On the opposing vertical side of the left forming arm, a left hinge 38 is provided for pivotally attaching the left swivel strut member 43. For added rigidity, a left arch brace 23 is rigidly connected to an upper end of the left forming plate 22 near the left receiving edge 86 and it spans to the other upper end of the left forming plate 22 behind the left hinge 38.

[0045] The right outer form 19 is similar to the left outer form 18. In particular, the right outer form 19 comprises a partial semi-circular right forming arch 26 mounted upright in a perpendicular manner to a right outer form plate 28. The right forming arch 26 is centered about a right pivot axis 32 having a radius R_4. The shape of the right outer form plate 28 of the exemplary embodiment conforms to a trapezoidal shape, however, the shape may vary as long as it performs the same function. The right outer form plate 28 has numerous functions including, providing structure for the right pivot axis 32, providing mounting structure for the right forming arch 26, and providing structure for securing or attaching devices, such as C-lamps or vice grips, (not shown or within the scope of the present invention) to secure and/or attach the right outer plate 28 in a rigid stationary position to a fixture (not shown). Supporting structure 84 may also be provided underneath right outer form plate 28. For example square steel tubing may be utilized as the support structure 84. Right outer form plate 28 has a right pivot hole 82 which is positioned at the right pivot axis 32. A right receiving edge 88 for receiving the center arched cord section 21 is provided along one of the vertical edges of the right forming arch 26. On the opposing vertical side of the right forming arch 26, a right hinge 40 is provided for pivotally attaching the right swivel strut member 44. For added rigidity, a right arch brace 27 is rigidly connected to an upper end of the right forming plate 26 near the right receiving edge 88 and it spans to the other upper end of the right forming plate 26 behind the right hinge 40.

[0046] It is noted that the radius of both the left forming arch 22 of left outer form 18 and the right forming arch 26 of the right outer form 19 may be varied according to the desired shape of the mounting structure 2. For instance, radius R_4 may be 6", 8", 10" or 12" or any other dimension. Therefore, the forming apparatus may have numerous sets of left and right outer forms 18, 19 for various production runs depending on the desired shape of the mounting structure 2.

[0047] Figures 6A and 8A best depict the center arched cord section 21. The center arched cord section 21 may be made from a formed laminate such as particle board, fiber board, plywood or a fiberglass panel to name just a few materials. The center arched cord section 21 is representative of the center arch span 10 shown in Figure 2. The center arched cord section 21 has left and right vertical edges which are adapted to be received in left receiving edge 86 and right receiving edge 88, respectively. The cord section 21 is rigidly attached to each receiving edge 86, 88 by a plurality of flat head screws or bolts with backing hardware such as nuts and washers. It is further noted that the radius and size of center arched section 21 may be varied according to the desired shape of the mounting structure 2. For instance, radius R_3 may be 44", 48", 50", 52" or 54" or any other dimension. Therefore, the forming apparatus 5 may have numerous sets of centered arched sections 21 for various production runs depending on the desired shape of the mounting structure 2.

[0048] The forming apparatus 5 is provided with a left adjustable strut assembly 41 and a right adjustable strut assembly 42. The left strut assembly 41 includes left swivel strut member 43, left threaded strut member 45, left swivel base 47, and left adjustment collar 46. One end of the left swivel strut member 43 is pivotally attached to left hinge 38. The other end of left swivel strut member 43 includes receiving threads to receive the left threaded strut member 45. Also, the adjustment collar 46 has receiving threads and is installed on the left threaded strut member 45. So that strut member 45 is rigidly fixed to an end of left swivel base 47. The other end of the left swivel base 47 is swivel attached to mounting gusset 52. The result is a left adjustable strut assembly 41 in which the length may be adjusted by rotating the adjustment collar 46.

[0049] The right strut assembly 42 includes right swivel strut member 44, right threaded strut member 48, right swivel base 50, and right adjustment collar 49. One end of the right swivel strut member 44 is pivotally attached to right hinge 40. The other end of right swivel strut member 44 includes receiving threads to receive the right threaded strut member 48. Also, the

adjustment collar 49 has receiving threads and is installed on the right threaded strut member 48. Strut member 48 is rigidly fixed to an end of right swivel base 50 and the other end of the right swivel base 50 is swivel attached to mounting gusset 52. The result is a right adjustable strut assembly 42 in which the length may be adjusted by rotating the adjustment collar 49.

[0050] Lateral support assembly 51 is best illustrated in Figures 6A-B, 7A-B. Lateral support assembly 51 comprises at least lateral jig 56, lateral strut 58, inclined strut 59, vertical support 54 and mounting gusset 52. In particular, lateral strut 58 and vertical support 54 are rigidly connected in a perpendicular orientation. Inclined strut 59 is attached to a mid-portion region of lateral strut 58 and to an upper mid-portion region of vertical support 54 at about a forty-five degree angle. Mounting gusset 52 is rigidly attached to an upper end of the vertical support 54 and is provided with a pair of bores for receiving fastening hardware for the swivel joints for attaching left swivel base 52 and right swivel base 50. Lateral jig 56 is mounted perpendicularly to at the center of main jig 36. The lateral jig 56 is preferably made from square tubing with preformed holes. Lateral strut 58 is preferably made from rectangular tubing which has outer dimensions slightly smaller than the inner dimensions of the lateral jig 56 such that lateral strut 58 may adjustably and slidably fit within lateral jig 56 with minimal looseness. The insertion end of lateral strut 58 is disposed with a series of receiving holes for receiving fastening hardware 57 to secure the insertion end of lateral strut 58 inside lateral jig 56.

[0051] Additionally, the forming apparatus 5 may have a plurality of winch assemblies 60-63 positioned on the vertical support 54. The exemplary embodiment of the forming apparatus 5 includes four winch and dual strap assemblies 60, 61, 62, 63 arranged in an alternating and offset manner about vertical support 54. In particular, and as best illustrated in Figures 7A-B, an upper left winch assembly 60 is attached on the most upper left hand side of vertical support 54. On the right hand side of the vertical support 54, an upper right winch assembly 62 is attached at a staggered height below the upper left winch assembly 60. Then on the left hand side of vertical support 54, a lower left winch assembly 61 is attached at a staggered height below the upper right winch assembly 62. And, on the right hand side of the vertical support 54, a lower right winch assembly 63 is attached at a staggered height below the lower left winch assembly 61. The winch assemblies 60-63 may include straps 69 which are adapted to be connected to individual straps 64-67 which are then wrapped around the entire form and tightened and/or

tensioned when a laminate 16 has been applied to the form. The operation of the winch assemblies 60-63 and individual straps 64-67 are discussed in further detail below.

Method of Utilizing the Forming Apparatus to Manufacture a Dual Radius Arch Frame Mounting Structure

1. Establish Dimensions and Parameters

[0052] A first aspect in manufacturing a dual radius arch frame mounting structure 2 is to define the desired dimensions or specifications of the mounting structure 2 to be manufactured. As previously discussed and illustrated in Figure 1, the mounting structure 2 has a specified span length L, center arch height H, width W, and thickness T.

[0053] The first dimension that should be determined is the span length L (see Figure 1). The span length L is typically dependent on the width of the conventional doorway 6 (see Figure 5). Next, the desired arch height H is selected (see Figure 1). Arch height H is a parameter which may be based upon personal preference, and therefore, arch height H may be lower or higher depending on the style of dual radius arch desired.

[0054] Once the span length L and arch height H are determined, the shape of the left downwardly curved section 9 and right downwardly curved section 11 are decided by selecting radius R_4. For instance, selection of a small R_4 results in a smaller left and right downwardly curved section 9, 10 and selection of a larger center arch span section 10 results in a short and flat dual radius arch. Whereas, utilizing a large R_4 results in a larger left and right downwardly curved region 9, 10 and a much shorter center arch span section 10, which results in a more semicircular-shaped dual radius arch.

[0055] Once R_4 has been selected, R_3 , which is also referred to as the "total rise" of the dual radius arch, may be determined. R_3 is determined by finding tangent points τ_L and τ_R about the left and right downwardly curved sections 9, 11 (see Figure 2). In particular, τ_L and τ_R are the points at which the center arch span 10 meets the desired arch height requirement H and also tangentially converges with the left and right downwardly curved sections 9, 11.

2. Set-Up Forming Apparatus

[0056] A second aspect in manufacturing a mounting structure 2 is to set-up forming apparatus or jig 5. With the main parameters of specified span length L, center arch height H, and radius parameters R_3 and R_4 determined, the forming apparatus or jig 5, may be set-up to form the desired dual radius arch window frame mounting structure 2.

[0057] Initially, a left outer form 18 and right outer form 19 are selected or fabricated which have a radius equal to the desired R_4. A distance of half the span length L minus R_4 ($\frac{1}{2}$ L - R_4) determines the distance at which the left and right pivot axis 30, 32 are positioned on a centerline 12 of the main jig 36. In particular, the distance of $\frac{1}{2}$ L - R_4 is measured from a center point of the jig 36. An appropriate positional mounting bore 25 is selected, and fastening hardware is installed into the left pivot hole 80 and right pivot hole 82 of the left and right outer forms 18, 19. As a result, the left outer form 18 is rotatably mounted to the main jig 36 along centerline 12 such that the left forming arch 22 is tangentially aligned with the left outer boundary of the span length L. And similarly, the right outer form 19 is then rotatably mounted to the main jig 36 along centerline 12 such that the right forming arch 26 is tangentially aligned with the right outer boundary of the span length L.

[0058] Once the left and right outer forms 18, 19 are positioned on the main jig 36, an appropriately sized center arched cord section 21 should be selected or fabricated which has a radius equal to the desired R_3 and of which has arc measurement of x radians (see Figure 2) or arc length l (see Figures 2, 6A). The center arched cord section 21 is then secured to the left receiving edge 86 of the left outer form 18 and the right receiving edge 88 of the right outer form 19. The cord section 21 may be rigidly attached to each receiving edge 86, 88 by a plurality of flat head screw or bolts with backing hardware such as nuts and washers.

[0059] Another aspect of the set-up process includes positioning lateral support assembly 51 and the left and right strut assemblies 43, 44. In particular, lateral support assembly 51 may be extended laterally away from the main jig 36 such that the "total rise" R_3 dimension is measured between the centered arch cord section 21 and the center cord axis 34 (see Figure 6A) or laterally offset centerpoint 15 (see Figure 2). Thus, the vertical support 54 is also laterally spaced away from the centered arch cord section 21 by about the same R_3 dimension. Next, the left and right strut assemblies 43, 44 may be adjusted by rotating the adjustment collars 46, 49 to either increase or decrease the length of the left and right strut assemblies 43, 44. The strut assemblies

43, 44 should be adjusted until a firm brace and/or support is provided between the respective left and right outer forms 18, 19 and the vertical support member 54. The left and right struts assemblies 43, 44 are utilized to prevent left and right outer forms 18, 19 from buckling inwards when they are under tension by straps 64-67.

[0060] A further aspect of the set-up process includes the installation of the center strut assembly 70 as shown in Figure 6B, 7A-B and 8A-B. Center strut assembly 70 includes center strut member 76 and center strut member threaded base 74, and threaded adjustment collar 78. The center strut assembly 70 may be utilized to provide additional bracing between the left outer form 18 and the right outer form 19 such that when straps 64-67 are tightened around the forming apparatus or jig 5, the left outer form 18 and the right outer form 19 do not buckle inwards. A first mounting hole 90 is disposed on the distal end of the center strut member 76 to receive fastening hardware which may be fastened to a portion of the right outer form 19. Furthermore, a second mounting hole 92 is disposed on the distal end of the center strut member threaded base 74, and is adapted to receive fastening hardware which may be fastened to a portion of the left outer form 18, such as the left arch brace 23. By adjusting the threaded center adjustment collar 78, the center strut assembly 70 may be expanded or contracted to provide a rigid and plum support utilized to prevent left and right outer forms 18, 19 from buckling inwards when they are under tension by straps 64-67. After this portion of the set-up is complete, the forming process of the dual radius arch frame 2 may begin.

3. Applying Laminate Sheets

[0061] As shown in Figure 3, the forming process of the dual radius arch frame 2 utilizes a lamination technique. Figure 6B illustrates how the laminate sheets 16 are applied and formed around the center arched cord section 21, left outer form 18, and right outer form 19. It is noted that the length of each individual laminate sheet 16 should be long enough to extend beyond the arch baseline 12. The laminate sheets 16 and adhesive 17 are applied using lamination techniques that are known by one of ordinary skill in the art. The number of laminate sheets 16 utilized to form the dual radius arch frame 2 may vary depending on the application.

[0062] Once the desired number of laminate sheets 16 have been laid to form the dual radius arch frame mounting structure 2, straps 64-67 may be connected to shackles 68 disposed on the connecting ends of winch straps 69 which are adapted to be wrapped within winch assemblies

60-63. The winch assemblies 60-63 may then be adjusted such that they are pulled taught against the plurality of laminates 16 composing the dual radius arch frame 2. After a period a time has past, the winches 60-63 may be disengaged or loosened such that straps 64-67 may be removed. The dual radius arch frame 2 may then be removed from the forming apparatus or jig 5. Finally, the dual radius arch frame 2 may be cut along the arch baseline 12 to desired dimensions.

[0063] Although the invention has been described with reference to several exemplary embodiments, it is understood that the words that have been used are words of description and illustration, rather than words of limitation. Changes may be made within the purview of the appended claims, as presently stated and as amended, without departing from the scope and spirit of the invention in its aspects. Although the invention has been described with reference to particular means, materials and embodiments, the invention is not intended to be limited to the particulars disclosed; rather, the invention extends to all functionally equivalent structures, methods, and uses such are within the scope of the appended claims.